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(54) **Field-emission type electronic device**

Mit Feldemission arbeitende elektronische Vorrichtung

Dispositif électronique du type à emission de champ

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(56) References cited:
EP-A- 0 354 750
EP-A- 0 406 886
EP-A- 0 416 625
EP-A- 0 443 865
US-A- 4 008 412

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a field-emission type electronic device according to the preamble of claim 1 containing an electron source which is operated to emit electrons on the principle of field emission

2. Description of the Related Art

Recently, remarkable progress has been made in a technique for manufacturing the field-emission type electronic device for emitting electrons in a high electric field in vacuum as a result of the development of fine technique utilized in the field of integrated circuits or thin film deposition In particular, a field-emission type cold cathode having a quite fine structure has been manufactured This type of field-emission type cold cathode is the most fundamental electron-emission device included in the essential parts of a micro electronic tube or electron gun.

The field-emission type electronic device or the field-emission type electron source containing many electron-emission devices has been invented for use as an essential component for a micro triode or a thin display element, for example The operation and the manufacturing method of the field-emission type electronic device or the field-emission type electron source are disclosed in the technical report: C.A Spindt, et. al of Stanford Research Institute, pp.5248 to 5263, Vol. 47, December (1976) of Journal of Applied Physics. Further, they have been disclosed in USP Nos 4307507 and 4513308 of H. F. Gray, et. al

In a conventional field-emission electron source, a substrate electrode is formed of monocrystalline silicon having low resistance in order to keep compatibility with fine technique in the field of integrated circuits or thin film deposition, of lower cost, and monolithic On the substrate electrode, many conical cold cathode chips are formed Each cold cathode chip is made of the same monocrystalline silicon as the substrate electrode or a high melting point metal such as tungsten (W) or molybdenum (Mo) An insulating layer is formed on the substrate electrode around the cold cathode chip. On the insulating layer, a gate electrode is deposited An anode electrode is provided to cover those cold cathode chips and the gate electrode while keeping vacuum space between the anode electrode and the side of the cold cathode chips and the gate electrode.

In such an electron source, a voltage of about 100 to 200 V is applied as a gate voltage between each cold cathode chip and the gate electrode. The application results in causing a strong electric field of about 10^7 V/cm between each cold cathode chip and the gate electrode, thereby allowing each cold cathode chip to emit electrons on the field-emission principle The anode voltage of 300 to 500 V applied to the anode electrode causes emitted electrons to reach the anode electrode

In the current techniques, the critical diameter of the conical cold cathode chip is about 1 μm and the critical height thereof is about 1 μm Further, it is practically impossible to avoid variable electron-emission characteristics in those chips caused by the variations of the cold cathode chips To overcome the disadvantageous matter, the anode electrode is made of a transparent material and a fluorescent material is coated on the transparent anode electrode A trial is now being made for a thin display unit using the cold cathode chips as electron-emission sources only In a case that this type of field-emission electronic device is applied to the thin display unit, it is unnecessary to accurately control the emitted electrons Hence, 1000 or more electron-emission cold cathode chips, which are arranged per one pixel in an array manner, are driven in parallel for the purpose of averaging the variation of the electron-emission cold cathode chips and obtaining the necessary amount of emitted electrons.

In a case that the field-emission cold cathode chips are used for a micro triode, the resulting triode may overcome the shortcomings and the limits entailed in the solid device such as a semiconductor device. The solid device has such a limit that the saturated travelling speed of electrons in the solid device is about c/1000 (c is the speed of light) On the other hand, in the field-emission electronic device, the emitted electrons travel in vacuum. Hence, the travelling speed of the electrons may be faster than the travelling speed of the electrons in the solid device by one or more digits. Further, the field-emission electronic device is more endurable in high temperature and radioactive rays For example, in a case that a voltage of 50 V is applied between the electrodes keeping a spacing of 1 μm therebetween, the travelling speed of electrons is 2 x 10^8 cm/s on average and the travelling time for a distance of 1 μm is 0 5 psec

The use of the triode having dimensions of sub-micron order, therefore, makes it possible to realize a super high-speed device having a response speed of tera-hertz level

In the known field-emission type electron source, a field-emission type cold cathode chip is formed in a conical form on a substrate electrode made of a metal or semiconductor material as mentioned above. An insulating layer is formed to cover the substrate electrode around the field-emission type cold cathode. On the insulating layer, a gate electrode is deposited. When a voltage is applied between the field-emission type cold cathode and the gate electrode, a high electric field takes place between the cold cathode and the gate electrode so that electrons can be emitted from the field-emission cold cathode on the basis of the field-emission principle

The field-emission cold cathode is made of silicon or metal such as tungsten (W) or molybdenum (Mo). Further trial is now being made for optimizing the form of the field-emission cold cathode in order to reduce an oper-

ating voltage at which electrons are emitted.

In another conventional field-emission electron source, like the foregoing composition, a field-emission cold cathode is formed in a conical form on a substrate electrode. An insulating layer is formed on the substrate electrode around the field-emission cold cathode. On the insulating layer, a gate electrode is deposited. The substrate electrode is made of semiconductor or metal. Unlike the foregoing composition, the substrate electrode is projected like a pyramid at the site where the conical field-emission cold cathode is to be formed. On the pyramid portion, a coating layer is deposited. The coating layer is made of a material having a low work function such as caesium (Cs) or lanthanum hexaboride (LaB6). This means that the pyramid portion of the substrate electrode and the coating layer deposited thereon compose the field-emission cold cathode.

Next, the shortcomings of the conventional compositions will be described.

For the known field-emission electronic devices, the following shortcomings take place. Since the distance between the cold cathode chip serving as a cathode electrode and the gate electrode is not made so small, it is necessary to apply a large voltage between the cathode electrode and the gate electrode for obtaining the necessary electric field to allowing the tip of the cold cathode chip to emit electrons. Further, since the distance between the cathode electrode and the anode electrode is made so larger, it take a considerable time for electrons to travel between the cathode electrode and the anode electrode.

The cold cathode chip has a cut-off frequency f_T represented by the expression:

$$f_T = g_m/(2\pi C_{gc})$$

wherein g_m is a mutual conductance and C_{gc} is a capacitance between the gate electrode and the cathode electrode.

To realize a cold cathode chip able to operate at high speed, therefore, it is necessary to increase the mutual conductance g_m but decrease the capacitance C_{gc}. However, in the structure of the known field-emission electronic devices, the electron emission is made possible only at the tip of the cold cathode chip. Further, since it is difficult to make the spacing between the adjacent cold cathode chips small in the light of the manufacturing technique, the area where electrons are emitted and the amount of emitted electrons are both small. Hence, it is difficult to increase the mutual conductance g_m of the electronic device depending on the current density of the field emission. Further, the field-emission electronic devices have the structure where the gate electrode layer is opposed to the cathode electrode layer keeping the insulating layer therebetween. This structure inevitably increases the value of the capacitance C_{gc} between the gate electrode and the cathode electrode.

In turn, for the first conventional field-emission electron source, in a case that the field-emission cold cathode is made of a high melting point metal such as tungsten (W), molybdenum (Mo) or titanium (Ti), those metals are thermally endurable and mechanically strong, but have so high work functions. For example, the work function of tungsten is about 4.3 eV and one of molybdenum is about 4.2 eV. They disadvantageously need high operating voltages.

For the second known composition of a field-emission electron source as mentioned above, the work function of the coating layer is so low, such as about 2.1 eV in case of using caesium (Cs) and about 2.7 eV in case of using lanthanum hexaboride (LaB_6). Hence, the operating voltage is made smaller. The difference of thermal expansion coefficient between the material of the coating layer and the material of the substrate electrode causes the resulting cold cathode to be thermally unstable and mechanically weak. Since the material of the coating layer is chemically active, a shortcoming takes place that the work function is subject to change. Additionally, since the material of the coating layer such as selenium has a far larger electrical resistance than the substrate electrode made of metal or semiconductor, the electric conduction between them is made worse, so that it is difficult for the electron emission to take place.

A field-emission type switching device according to the prior art portion of claim 1 in which an emitter electrode and a collector electrode are formed as conductive layer portions on a common insulating layer and separated by a recess at the bottom of which a gate electrode is formed, is disclosed in EP-A-0 406 886.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a field-emission electronic device which is capable of realizing high-speed operation.

The present invention provides a field-emission electronic device including a cathode electrode for emitting electrons using the principle of field emission, the device further including a gate electrode spaced from said cathode electrode, characterized in that said cold cathode and gate electrodes are formed on respective insulating members supported on a common base member and mutually spaced apart with a gap therebetween, an anode electrode being provided at least at the base of said gap.

The dependent claims relate to features of preferred embodiments of the present invention.

In the field-emission electronic device according to the present invention the distance between the electrodes is made smaller than in the known field-emission electronic device. Specifically the distances between the cathode electrode and the gate electrode and between the cathode electrode and the anode electrode are allowed to be reduced. This results in lowering a gate voltage and an anode voltage. The value of the capacitance between the cathode electrode and the gate electrode can be made smaller as compared to the known

field-emission electronic device wherein the cathode electrode and the gate electrode are laminated with the insulating layer laid therebetween. In a case that the anode electrode is provided on a substrate located between the cathode electrode and the gate electrode, the values of capacitance caused between the cathode electrode and the anode electrode and between the gate electrode and the anode electrode can be reduced.

For example, if a voltage of 20 V to 100 V is applied between the cathode electrode and the gate electrode, a strong electric field of about 10^7 V/cm takes place between the tip of the cathode electrode and the gate electrode in quick response to the application of the voltage. The cold cathode tip serves to emit electrons at its upper tip on the basis of the field-emission principle.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing a field-emission electronic device according to a basic embodiment of the invention,

Fig. 2 is a sectional view cut on the line II-II of Fig. 1;

Figs. 3 to 11 are partial plane views each showing a field-emission electronic device according to a respective further embodiment of the invention, and

Fig. 12 is a schematic sectional view showing a method for manufacturing the field-emission electronic device of Fig. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 is a perspective view showing the field-emission electronic device. Fig. 2 is a sectional view cut on the II-II line of Fig. 1.

A field-emission electronic device employs as its substrate a high-resistance monocrystalline silicon substrate 4 such as a non-doped silicon substrate. On the silicon substrate 4, there is formed an anode electrode layer 3 made of molybdenum. On the anode electrode layer 3, a cathode electrode layer 1 is located with an insulating layer 5 laid therebetween and a gate electrode layer 2 is located with an insulating layer 6 laid therebetween. The cathode electrode layer 1 is opposed to the gate electrode with a groove 7 laid therebetween. The insulating layer 5 and 6 are both made of silicon dioxide. The cathode electrode layer 1 and the gate electrode layer 2 are both made of molybdenum. The horizontal distance dl between the cathode electrode layer 1 and the gate electrode layer 2 is set as 0.1 to 0.5 µm. The thickness h1 of the insulating layer 5 is set as 0.2 to 1.0 µm and the thickness h2 of the insulating layer 6 is set as 0.1 to 0. 5 µm in a manner to keep a relation of h1>h2. That is, the gate electrode layer 2 is provided between the anode electrode layer 3 and the cathode electrode layer 1.

As shown in Fig. 1, two layers opposed to each other with the groove 7 laid therebetween are formed to have a sawtooth form. The cathode electrode layer 1 serves to emit electrons at the tip of the sawtooth. There are arranged a plurality of linear-array sawtooth portions each having a lot of electron emitters. The tip 1a of the cathode electrode layer 1 is made acute in a manner to be inclined toward the gate electrode layer 2. The acute tip 1a is projected from the insulating layer 5 toward the groove 7. Likewise, the tip 2a of the gate electrode 2 is projected from the insulating layer 6 toward the groove 7.

As a material for each electrode layer, molybdenum is used. It is possible to use the conventional electrode materials such as chromium, tungsten, gold, silver, copper, aluminum. Any material may be used for the insulating layer if it has an insulating characteristic.

In the field-emission electron device arranged as above, when a voltage of about 20 V to 100 V is applied between the cathode electrode 1 and the gate electrode 2, a strong electric field of about 10^7 V/cm takes place between the tip of the cathode electrode 1 and the gate electrode 2, so that the cathode electrode 1 may emit electrons at its tip on the field-emission principle. The emitted electrons reach the anode electrode layer 3 to which a predetermined voltage has been applied. As such, the groove 7 is an electron-moving space for the electrons emitted from the acute tip 1a of the cathode electrode 1. The amount of electrons emitted from the cathode electrode 1 increases or decrease as the gate voltage changes. Since the change of the gate voltage appears as the change of the anode current, therefore, the field-emission electronic device operates as a triode device.

As mentioned above, the distance between the electrodes is made to be changed from a known value of about 1 µm to a smaller value. Hence, it is possible to obtain the intensity of an electric field required for field emission when a lower voltage is applied to the gate. Further, since a distance between the anode electrode and the cathode electrode, that is, a thickness h1 of the insulating layer 5 can be set as 0.2 to 1.0 µm, it is possible to reduce the voltage applied to the anode and a time taken in moving electrons between the anode electrode and the cathode electrode. Moreover, in the field-emission electronic device according to this embodiment, as compared to the lamination of the cathode electrode and the gate electrode in the known structure, the overlapping area of the cathode electrode with the gate electrode can be reduced, resulting in making the capacitance between the cathode electrode and the gate electrode smaller. As such, the electronic device is capable of providing so large a cut-off frequency that it may operate at high speed.

In turn, the description will be directed to a field-emission electronic device according to another embodiment of the invention as referring to Figs.3 to 11. Each structure shown in each figure corresponds to one embodiment.

Figs. 3 to 5 show a lamination composed of an insulating layer and a gate electrode layer, a lamination

composed of an insulating layer and a cathode electrode layer, and a planar form of a groove spacing these layers from each other, respectively. Fig. 3 shows the same planar form of the lamination as that of the first embodiment. It has a structure where the mountains and the valleys of a sawtooth cathode electrode 11 engage with those of a sawtooth gate electrode 12. Fig. 4 shows the tip of the sawtooth cathode electrode 13 which is made more acute than that shown in Fig. 3. The gate electrode 14 is provided around each acute tip. In this structure, the electric field is more effectively concentrated on the tip of the cathode electrode 13 through the form effect. It is therefore possible to reduce the gate voltage. However, the field emission takes place only at the tips. This results in inevitably making the field-emission area small. Fig. 5 shows a structure where the convexities and concavities of the cathode electrode are engaged with those of the gate electrode without using acute tips. As compared to the structures shown in Figs. 3 and 4, the field concentration is disadvantageously made smaller, while the area for emitting electrons is advantageously made larger.

The structure shown in Fig. 3 has an intermediate feature between the structure shown in Fig. 4 and that shown in Fig. 5. That is, it is possible to set the planar form of the cathode electrode or the gate electrode in a manner to suit to the required feature.

Figs. 6 to 8 show other sectional forms of the tip of the cathode electrode layer in the groove served as an electron-moving space, respectively. The structure shown in Fig 6 is the fundamental form. The tip 21a of the cathode electrode 21 is projected from the insulating layer 24 without changing the thickness of the tip 21a at the same level of the cathode electrode 21 on the insulating layer 24. This structure provides the tip of the cathode which is excellent in mechanical strength and is allowed to be manufactured by an easier process. The structure shown in Fig. 7 provides the tip 31a of the cathode electrode 31 projected in a manner to be inclined toward the gate electrode 32. This structure is formed by considering the optimization of the distribution of an electric field around the tip of the cathode electrode 31 and the direction of electron emission based on the field emission. The structure shown in Fig.8 is formed so that the tip 41a of the cathode electrode 41 is made acute toward the thickness of the cathode electrode. This structure offers an advantage that an electric field is concentrated around the tip 41a of the cathode electrode 41 through the form effect. The advantage makes it possible to lower the gate voltage. The structure shown in Figs. 1 and 2 is a combination of the structure shown in Fig. 7 and the structure shown in Fig. 8.

As described above, the field-emission electronic device according to the present invention enables to freely take a form of an electron-emitting portion of the cathode electrode and orient the tip. Hence, the field concentration around the cathode tip can be effectively implemented, resulting in achieving the increase of an emitted current density based on the field emission.

As shown in Fig. 9, the field-emission electronic device may provide a conductive anode electrode substrate 53 having an integral combination of the substrate and the anode electrode. For the anode electrode substrate 53, a low-resistance monocrystalline silicon substrate or a metal plate may be used. In a case that the anode electrode substrate 53 is made of monocrystalline silicon, an oxidized silicon layer formed by heat oxidation may be used for insulating layers 55 and 56 in light of the manufacturing process. The silicon dioxide layer obtained by thermally oxidizing monocrystalline silicon is more excellent in an insulating characteristic as compared to the layer formed by vacuum evaporation, for example. Hence, it is suitable as the insulating layer. In addition, the silicon substrate is allowed to be monolithically integrated with another electronic component. This makes a contribution to simplifying the manufacturing process.

As a structure of another embodiment, as shown in Fig. 10, a belt-like (extending in a direction perpendicular to the paper) anode electrode layer 63 is deposited on the surface of the silicon substrate 64 located on the bottom of a groove 67. As a structure of another embodiment, as shown in Fig. 11, a belt-like (extending in a direction perpendicular to the paper) anode electrode layer 73 is buried in the silicon substrate 74 in a manner to expose its surface on the bottom of a groove 77. Herein, the substrate 74 employs a high-resistance monocrystalline silicon substrate such as a non-doped silicon substrate and the anode electrode 73 may be formed of an n-type low-resistance area by doping an n-type impurity such as phosphorus on the belt-like part of the substrate 74. The low-resistance area may be a p-type low-resistance area formed by doping a p-type impurity such as boron. In the structures shown in Figs. 10 and 11, the area of the anode electrode layer occupying the substrate is made smaller. This makes it possible to reduce the overlapped area of the cathode electrode and the anode electrode (against the substrate surface) and the overlapped area of the gate electrode and the anode electrode. As such, it is possible to reduce the capacitances between the cathode electrode and the gate electrode, between the cathode electrode and the anode electrode and between the gate electrode and the anode electrode. This results in increasing a cut-off frequency f_T of the device, thereby enabling operation of the electronic device at high speed.

In turn, the description will be directed to a process for manufacturing a field-emission electronic device according to the first embodiment as referring to Fig. 12.

The manufacturing method according to this embodiment is arranged to independently set each interval between the anode electrode and the gate electrode, between the gate electrode and the cathode electrode, or between the anode electrode and the cathode electrode. Further, the method makes it possible to make the cathode electrode acute or orient the acute electrode in re-

spective steps. In addition, the method needs just one transfer of a fine mask pattern to a resist. As such, there is no need to accurately position the mask pattern.

The sections shown in Figs. 12a to 12f show the respective manufacturing steps. As shown in Fig. 12a, an anode electrode metal layer 83 having a thickness of about 0.1 μm is deposited on a substrate 84. An insulating layer 86a having a thickness of about 0.3 μm is deposited on the layer 83. Then, a gate electrode metal layer 82a having a thickness of about 0.1 μm is deposited on the insulating layer 86a. Further, a resist mask 88 is formed on the layer 82a. The thickness of the insulating layer 86a corresponds to an interval between the anode electrode and the gate electrode. The electrode metal layers 83, 82a and the insulating layer 86a have been formed by the electron-beam evaporating technique. Instead, the sputtering technique or the CVD technique may be used according to the used material.

Next, along the mask 88, as shown in Fig. 12b, the gate electrode metal layer 82a is selectively etched for removal. Then, the gate electrode metal layer 82a is side-etched by a width shown by d81. The side-etched length d81 corresponds to a horizontal distance between the cathode electrode 81 and the gate electrode 82. Next, like the removal of the gate electrode metal layer 82a, the insulating layer 86a is etched for removal.

As shown in Fig. 12c, an insulating layer 85a is formed by the vacuum evaporating technique using an electron beam. Herein, by moving the evaporating source or rotating the substrate 84, as shown by an arrow B, the angle of evaporating direction is relatively changed by several degrees (up to 20). Then, the insulating layer 85a is evaporated toward the mask 88 in a manner to make its thickness somewhat smaller. With the evaporation, it is possible to set the direction of the tip of the cathode electrode. The thickness of the overall insulating layer 85a corresponds to an interval between the anode electrode and the cathode electrode. As shown in Fig. 12d, the cathode electrode metal layer 81 is formed by the electron-beam vacuum evaporating technique. By moving the evaporating source or rotating the substrate 84, as shown by an arrow C, the angle of the evaporating direction is allowed to be relatively changed from a few up to twenty degrees. The cathode electrode metal layer 81 is evaporated against the resist mask 88 in a manner to make the metal layer 81 more acute toward its thickness. Thereafter the mask 88, the insulating layer 85b deposited on the mask, and the cathode electrode material layer 81a deposited on the layer 85b are all removed. The resulting structure is as shown in Fig. 12e. Further, the insulating layers 85a and 86b are side-etched so that the acute tip of the cathode electrode 81 and the tip of the gate electrode 82 are allowed to be projected toward the groove 87. The resulting structure is as shown in Fig. 12f. This is an intended field-emission electronic device.

With this manufacturing method, it is possible to manufacture the field-emission electronic device which provides a lower operating voltage and a high-speed operation.

Claims

1. A field-emission electronic device including a cathode electrode (1;51;61;71;81) for emitting electrons using the principle of field emission, the device further including a gate electrode (2;52;62;72;82) spaced from said cathode electrode, characterized in that said cold cathode and gate electrodes are formed on respective insulating members (5,6;55,56;65,66; 75,76;85,86) supported on a common base member (4;53;64,74,84) and mutually spaced apart with a gap (7;57;67;77;87) therebetween, an anode electrode (3;53; 63;73,83) being provided at least at the base of said gap.

2. A field-emission electronic device according to claim 1, wherein said cathode electrode comprises a layer (11;13) which is shaped like a sawtooth in plane and said gate electrode comprises a layer (12;14) which is shaped in such a manner that outline thereof is parallel to and spaced from outline of said sawtooth-shaped cathode electrode layer.

3. A field-emission electronic device according to claim 1, wherein said cathode electrode comprises a layer (15) which has flat topped projecting portions and is shaped in such a manner that said flat topped projecting portions are arranged at regular intervals in plane, and said gate electrode comprises a layer (16) which is shaped in such a manner that outline thereof is parallel to and spaced from outline of said cathode electrode layer.

4. A field-emission electronic device according to claim 2 or claim 3, wherein said cathode electrode layer (21;41) projects outwardly at the same level with a part thereof on its associated insulating member (24).

5. A field-emission electronic device according to claim 2 or claim 3, which said cathode electrode layer (31;51;61;71,81) projects outwardly in a manner to be inclined toward said gate electrode layer (22;32;52;62;72; 82).

6. A field-emission electronic device according to claim 5, wherein a projecting portion (1a;31a) of said cathode electrode layer (1;31) makes an acute angle with respect to the major plane of the cathode electrode layer (1;31).

Patentansprüche

1. Elektronisches Feldemissions-Bauteil mit einer Kathodenelektrode (1, 51; 61, 71; 81) zum Emittieren von Elektronen unter Verwendung des Feldemissionsprinzips, und ferner mit einer von der Kathodenelektrode beabstandeten Gateelektrode (2, 52; 62, 72, 82), **dadurch gekennzeichnet, daß** die Kaltkathode und Gateelektroden auf jeweiligen Isolierteilen (5, 6, 55, 56, 65, 66, 7 5, 76, 85, 86) ausgebildet sind, die von einem gemeinsamen Trägerteil (4; 53; 64; 74; 84) gehalten werden und unter Einhaltung eines dazwischenliegenden Spalts (7; 57; 67, 77, 87) voneinander beabstandet sind, wobei eine Anodenelektrode (3, 53, 63, 73, 83) zumindest am Boden des Spalts vorhanden ist.

2. Elektronisches Feldemissions-Bauteil nach Anspruch 1, bei dem die Kathodenelektrode eine Schicht (11, 13) aufweist, die in der Ebene sägezahnförmig ausgebildet ist und die Gateelektrode eine Schicht (12, 14) aufweist, die auf solche Weise geformt ist, daß ihre Kontur parallel zur Kontur der sägezahnförmigen Kathodenelektrodenschicht verläuft und von dieser beabstandet ist.

3. Elektronisches Feldemissions-Bauteil nach Anspruch 1, bei dem die Kathodenelektrode eine Schicht (15) aufweist, die über vorspringende Abschnitte mit flacher Oberseite verfügt und auf solche Weiso geformt ist, daß diese vorspringenden Abschnitte mit flacher Oberseite in einer Ebene mit regelmaßigen Abstanden angeordnet sind, und bei dem die Gateelektrode eine Schicht (16) aufweist, die auf solche Weise geformt ist, daß ihre Kontur parallel zur Kontur der Kathodenelektrodenschicht verläuft und von dieser beabstandet ist.

4. Elektronisches Feldemissions-Bauteil nach Anspruch 2 oder Anspruch 3, bei dem die Kathodenelektrodenschicht (21, 41) mit einem Teil derselben auf demselben Niveau auf ihrem zugehörigen Isolierteil (24) nach außen vorspringt.

5. Elektronisches Feldemissions-Bauteil nach Anspruch 2 oder Anspruch 3, bei dem die Kathodenelektrodenschicht (31; 51; 61; 71; 81) auf solche Weise nach außen vorspringt, daß sie zur Gateelektrodenschicht (22; 32, 52; 62, 72, 82) hin geneigt ist.

6. Elektronisches Feldemissions-Bauteil nach Anspruch 5, bei dem ein vorspringender Abschnitt (la; 31a) der Kathodenelektrodenschicht (1; 31) zur Hauptebene der Kathodenelektrodenschicht (1; 31) einen spitzen Winkel einnimmt.

Revendications

1. Dispositif électronique d'émission de champ incluant une électrode de cathode (1, 51; 61, 71; 81) pour émettre des électrons en utilisant le principe de l'émission d'un champ, le dispositif comprenant également une électrode de grille (2, 52; 62, 72, 82) espacée de ladite électrode de cathode, caractérisé en ce que lesdites électrodes de cathode froide et de grille sont formées sur des éléments isolants respectifs (5, 6, 55, 56, 65, 66, 75, 76, 85, 86) supportés sur un élément de base commun (4, 53, 64, 74, 84) et espacés mutuellement avec un intervalle (7, 57, 67, 77; 87) entre eux, une électrode d'anode (3, 53, 63, 73, 83) étant prévue au moins à la base dudit intervalle.

2. Dispositif électronique d'émission de champ selon la revendication 1, dans lequel ladite électrode de cathode comprend une couche (11; 13) qui est formée en dent de scie dans un plan et ladite électrode de grille comprend une couche (12; 14) qui est formée de telle manière que son contour est parallèle au contour de ladite couche d'électrode de cathode en forme de dent de scie et est espacé par rapport à ce dernier.

3. Dispositif électronique d'émission de champ selon la revendication 1, dans lequel ladite électrode de cathode comprend une couche (15) qui comprend des portions en projection au sommet aplati et est formée de telle manière que lesdites portions en projection au sommet aplati sont prévues à intervalles réguliers dans un plan, et ladite électrode de grille comprend une couche (16) qui est formée de telle manière que son contour est parallèle au contour de ladite couche d'électrode de cathode en forme de dent de scie et est espacé par rapport à ce dernier.

4. Dispositif électronique d'émission de champ selon la revendication 2 ou 3, dans lequel ladite couche d'électrode de cathode (21, 41) se projette vers l'extérieur au même niveau qu'une partie de celle-ci se trouvant sur son élément isolant associé (24).

5. Dispositif électronique d'émission de champ selon la revendication 2 ou 3, dans lequel ladite couche d'électrode de cathode (31; 51, 61, 71, 81) se projette vers l'extérieur de manière à être inclinée vers ladite couche d'électrode de grille (22; 32; 52; 62; 72; 82).

6. Dispositif électronique d'émission de champ selon la revendication 5, dans lequel une portion en projection (1a; 31a) de ladite couche d'électrode de cathode (1; 31) forme un angle aigu par rapport au plan principal de la couche d'électrode de cathode (1, 31).

Fig. 1

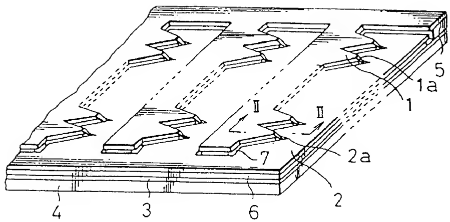

Fig. 2

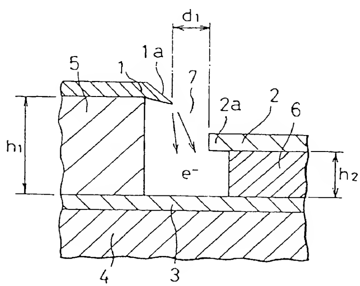

Fig. 3

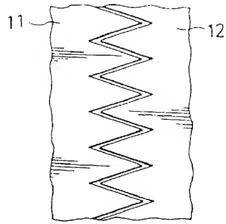

Fig. 4

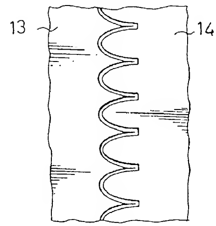

Fig. 5

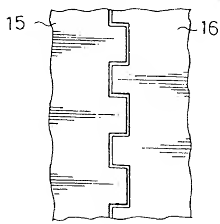

Fig. 6

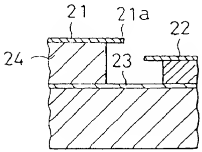

Fig. 7

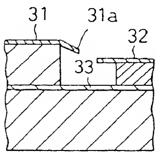

Fig. 8

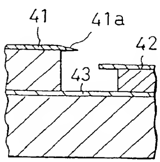

Fig. 9

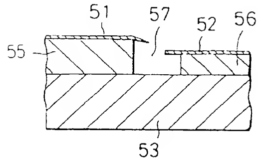

Fig. 10

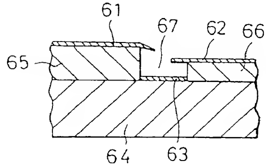

Fig. 11

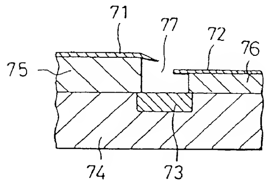

Fig.12a

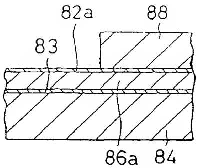

Fig.12d

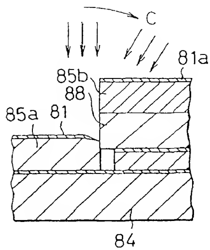

Fig.12b

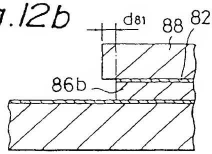

Fig.12e

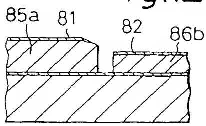

Fig.12c

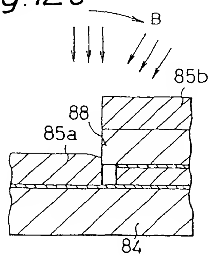

Fig.12f